Transport and the Greenhouse Effect

The Role of Research in Kyoto-Related Climate Policy in The Netherlands

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*To date, 84 nations have signed the so-called Kyoto Protocol on the control of Greenhouse Gas (GHG) emissions. In the Netherlands the Kyoto agreement has resulted in quantitative national targets for 2008-2012 of -6% GHG emission reduction compared to 1990; this is a reduction of 19% compared to the emission forecasted for 2010. Two years ago the Dutch government launched a policy-making process for meeting the Kyoto target. In both the development and the evaluation of Dutch Kyoto-related policy, research has played a major role. For the transport sector no (*a priori*) targets were set; however, a list of measures and instruments to reduce transport GHG emissions were discussed in the Kyoto-related policy-making process. Nearly all transport instruments and measures on this list appeared to be car-related. The reason for this focus was an* a priori *choice of policymakers. However, cost-effective options for other vehicle categories (road and non-road transport) may be available. The transport options finally chosen for the Policy document will reduce GHG emissions from transport by 3-5% compared to the forecasted 2010 emissions. Researchers estimated that tax differentiation for new cars and in-car instruments such as fuel economy meters and cruise control will be the most effective instruments. The selected transport measures were not really chosen to induce a technology push; rather, the selection was mainly policy driven to meet short-term targets. Although research played a significant role in the policy-making process, several research improvements can still be made. Important improvements identified are: a) using a better and clearer method for the calculation of the costs of the measures and b) using a broader evaluation method of measures; this will mean including more environmental, economic and social indicators.*

1. Introduction

The enhanced greenhouse effect is caused by increased atmospheric concentrations of gases like carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorine- containing compounds (HFCs, PFCs and SF_6). The enhanced greenhouse effect will result in global climate changes and as a result will probably affect such aspects as world food production and ecosystems. Scientifically speaking, there is currently a fair level of consensus about the relationship between human activities and climate change. In 1995 the United Nations Intergovernmental Panel on Climate Change (IPCC) concluded that: '*…the balance of evidence suggests that there is a discernible human influence on global climate*' (IPCC, 1995). Transport, the subject of this paper, is one the human activities causing greenhouse gas (GHG) emissions.

Possible human-induced climate change leads to political concerns. In the mid-nineties it became clear to most countries that further political steps would be required to reduce the emissions of greenhouse gases. For this reason, many nations signed the so-called Kyoto Protocol on the control of Greenhouse Gas (GHG) emissions on 10 December 1997. To date, 84 nations have signed the Protocol, which prescribes a 5% reduction in greenhouse gases by most of the developed countries between 2008 and 2012 compared to the emission levels in 1990/1995. Each industrialised zone in the world has its own goal: for the EU it is -8%, for the USA -7% and for Japan -6%.

In 1998 the European Council allocated the EU obligation in the Kyoto Protocol (-8%) among individual member states. A reduction obligation of 6% has been agreed on for the Netherlands (VROM, 1999). About two years ago policymakers in the Netherlands started discussing how to meet this 6% emission reduction obligation. It soon became obvious that transport would be one of the contributing sectors in meeting the Dutch obligation. This paper will discuss the process which has finally led to a policy aimed at the a reduction of CO_2 emissions in the Dutch transport sector (VROM, 1999). The main questions to be addressed in this paper are:

a) What has been the role of research in this policy-making process?
b) What is the result of this process for the transport sector in the Netherlands? and
c) What lessons for policy-making processes can be learned for the future?

2. Transport and CO_2 emission in the Netherlands

In the industrialised countries (US, EU and Japan) the average CO_2 emissions by all sources increased by 9% in the 1990-1997 period (IEA, 2000). According to the same study, it is expected that without new initiatives greenhouse gas emissions in these countries are likely to increase some 30% above the 1990 levels in the Kyoto time frame of 2008-2012. The trend in the Netherlands shows roughly the same picture (Table 1), although the future growth of GHG emissions is expected to be somewhat lower.

Table 1 Greenhouse gas emissions in the Netherlands in Mtonne CO_2 equivalents[1]

	1990	1995	2010 BAU*
Transport	31	34	40
Other sectors	186	200	219
Total	217	234	259

* BAU = Business-As-Usual scenario, based on a relatively high economic growth scenario

Source: RIVM (1999), ECN/RIVM (1998)

Total Dutch GHG emissions are expected to grow by roughly 20% in the 1990-2010 period. Compared to the Kyoto agreement (6% reduction in this period), this figure shows that a relatively large policy effort will be required to meet the obligation. In the 1990-2010 period transport GHG emissions in the BAU scenario will increase by approximately 30%. As in most other countries (IEA, 2000), this trend also points to the Netherlands as experiencing an increase in fossil fuel use in passenger and freight transport in the near future.
Road transport is by far the most important contributor of CO_2, resulting from emissions (Table 2)[2]. In contrast to the figures in Table 1, Table 2 shows only the CO_2 emissions from transport. In the transport sector CO_2 contributes more than 90% to total GHG emissions.

Table 2 Trend in transport CO_2 emissions in the Netherlands

	1990	1995	2010 BAU
Only CO_2			
Passenger cars	16.0	17.8	17.8
Other road transport	9.4	10.9	16.0
Non-road transport	3.2	3.3	4.0
Total	29	32	38

Source: RIVM (1999), ECN/RIVM (1998)

As shown in Table 2, the category ‘other road transport’ (mainly vans and lorries) explains most of the growth in the national transport emissions in BAU. This is due to the expected high volume of growth of vans and lorries (about 70-80% in the 1995-2010 period) in combination with an expected low-energy efficiency improvement. In BAU 2010, energy use (MJ/km) of vans and lorries is expected to be about 13% lower than the level of energy use in 1995 (Geurs *et al.*, 1998).

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[1] The concept of CO_2 equivalents makes it possible to compare emissions of different greenhouse gases. The comparison is based on differences in the greenhouse warming potential of the gases.

[2] The international emissions due to bunkered fuels on Dutch territory for mainly ocean-going shipping and aircraft are excluded from the national totals in accordance with the Kyoto Protocol. Emissions due to bunkered fuels come to 47 Mtonnes in 1995 and 70 Mtonnes in 2010 (BAU) (Feimann *et al.*, 2000). The Kyoto Protocol has recommended that the international maritime and aircraft organisations study options to reduce GHG emissions in the international transport sectors.

The figures as presented in Tables 1 and 2 make it clear to Dutch politicians that a large effort will be required to fulfil the Kyoto agreements. Therefore a policy-making process based on the –6% CO_2 emissions target for all sources was launched.

3. The policy-making process

The process started off by defining the policy task, i.e. the gap between the expected level of emissions in BAU (2010) and the EU agreement (6% emission reduction for the Netherlands). Defining the policy task was the responsibility of the policymakers. Policy makers chose to base BAU on a high growth macro-economic scenario. Compared to the other available Dutch macro-economic scenarios (a low and middle growth scenario; see Geurs *et al.*, 1998), this scenario was assessed as being the most plausible.
In the Kyoto Protocol the decision of taking 1990 or 1995 as base year for these compounds is left to the individual countries. The base years used for the 6% reduction obligation is 1990 for CO_2, CH_4 and N_2O (according to the Kyoto Protocol); 1995 was chosen for the fluorine-containing compounds . On the basis of these choices, the policy task is calculated to be 50 Mtonne GHG emission reduction in the year 2010 (VROM, 1999). The Kyoto Protocol determines that the principal part of the obligation should be met by domestic CO_2 emission reduction. However, Dutch policy has decided that approximately 50% of the reduction effort will be aimed at foreign parties, using policy instruments such as ‘Joint Implementation’, ‘Clean Development Mechanism’ and ‘Emission Trading’. So the resulting domestic policy task amounts to 25 Mtonne emission reduction in 2010. To be clear: this 25 Mtonne emission reduction is valid for the total of all sources, not only transport.
The second step in the process was to describe policy options that could contribute to the reduction obligation. It is important to note that the policymakers did not choose to set targets for different economic sectors. They asked researchers for an Option document containing measures and instruments for all economic sectors in the Netherlands. They wanted to use this list of options to construct sets of ‘feasible’ policy instruments. Policy makers from the different ministries (e.g. Environment, Economic Affairs and Transport) were grouped together. These groups selected lists of policy options per economic sector (Table 3 shows the options selected for the transport sector). They also defined criteria to be used by researchers to assess the effects of the chosen policy instruments and measures. These criteria were:

a) potential CO_2 emission reduction in 2010 (in CO_2 equivalents),
b) costs for the end-user and the national total and the expenditures for the government in 2010,
c) the possibilities for instrumentation of the measures,
d) the influence that timing of policy instrument implementation has on emissions and costs,
e) the potential public and political support, and
f) potential side-effects, e.g. reduction in emissions from other substances.

Researchers were responsible for the assessment. Results were published in the so-called Option Document (ECN/RIVM, 1998).

On the basis of the Option Document, policymakers selected a set of measures and instruments to intensify the current GHG emission reduction policy and to meet the obligation of 25 Mtonne GHG emission reduction. This resulted in the so-called 'Policy document on climate policy'(VROM, 1999). The guiding principle of selection was said to be cost-effectiveness: instruments or measures which cost more than 70 Euro per tonne CO_2 equivalent were considered too expensive. However, other criteria also played a role in the selection. These criteria involved the potential public support and instrumentation.
The last steps of the policy-making process dealt with evaluation and monitoring. In evaluating the Policy document, researchers could estimate the impact of this document on GHG emission reduction.

Table 3 Transport measures and instruments in the Option document (ECN/RIVM, 1998)

Measure/Instrument	Aimed at
Increase levies on fuels per 1 January 1999* (petrol, diesel at 22 Euro cents per litre; LPG 16 Euro cents)	Fewer car kilometres and improved energy efficiency compared to BAU
Increase levies on fuels per 1 January 2003 (petrol and diesel 22 Euro cents per litre; LPG 16 Euro cents)	Fewer car kilometres and improved energy efficiency compared to BAU
Energy labelling for cars to inform consumers on the energy use of new cars	Improved energy efficiency of cars compared to BAU
Feebate system on car purchase tax (45 Euro per g/km CO_2)	Improved energy efficiency of cars compared to BAU
Car owner tax differentiation based on energy use and not, as in BAU, on weight	Improved energy efficiency of cars compared to BAU
Increase the tire pressure	Improved energy efficiency of cars compared to BAU
Improved enforcement of current speed limits on motorways (partly 120 and 100 km/h)	Improved energy efficiency of cars compared to BAU
Improved enforcement of the 100 km/h speed limit on motorways	Improved energy efficiency of cars compared to BAU
Adjusting lorry speed limiters from 89 km/h (BAU) to 80 km/h	Improved energy efficiency of lorries compared to BAU
Promoting the use of econometers, cruise control, board computers in cars	Improved energy efficiency of cars compared to BAU
Training to improve driving behaviour of car drivers	Improved energy efficiency of cars compared to BAU
Road pricing	Solving congestion
Avoiding short car trips (trips with a distance < 5 km)	Fewer car kilometres
Fiscal measures to discourage car use in commuting	Fewer car kilometres

* During the preparation of the Option document, the feasibility of its introduction in 1999 was already heavily doubted. However, this instrument's purpose was to show the importance of timing.

As shown in Table 3, policymakers selected 14 transport measures and instruments. Four important observations can be made. The first is that the choice of options seemed to be highly driven by possible feasibility of implementation in the short term (in the 2000-2005 period). The options are well known and attempt, for example, to improve car energy efficiency slowly and use existing technology. No options have been selected which could be regarded as inducive to a technology push in transport in the long term. In the Policy document some attention is given to 'technology-pushes', but the separate section on this subject can be characterised as 'without obligations'. The second observation is that most of the options are aimed at cars. The reason is that policymakers decided that cars would be the easiest transport category in which to implement short-term CO_2 emission reduction policies. The third observation is that all the options are aimed at CO_2. In the Option document some attention is paid to potential N_2O car emission reduction. Based on the highly uncertain N_2O emission data, the document recommends carrying out new measurements before defining options to reduce these emissions. The last observation has to do with the difference between the notion of 'measure' and 'instrument'. Some options as given in Table 3 were formulated as instruments: it was clear *how* policymakers want to achieve an impact. For these cases, impact could be estimated in a fairly straightforward fashion. However, most selected options were 'measures'. They described only *what* policymakers wanted to achieve, but not *how* to achieve goals; this remained unclear. In other words, instrumentation for achieving goals was completely lacking or remained unclear. Examples are: 'avoiding short car trips' (but how?), 'promoting the use of cruise control and an econometer' (but how?), 'enforcement of new speed limits' (but what is meant by 'enforcement'?). The lack of clear instrumentation was solved by carrying out 'what-if' analyses. For example, what is the CO_2 emission reduction if 100% of the fleet uses econometers, or what is the CO_2 emission reduction if all car and van users adhere to the agreed speed limits? Although researchers attempted to be very clear about the assumptions used in the Option document, some 'what-if' analysis resulted later on in misunderstandings and misinterpretations in the policy process.

4. Results

The Option document (ECN/RIVM, 1998) and all kinds of additional discussion finally resulted in a Policy document (VROM, 1999). Table 4 shows what Kyoto-related policy the Dutch government is planning to use for the transport sector. It also shows what kind of instrumentation is planned and what the Policy document expects as the resulting emission reduction in 2010 compared to BAU. According to the policy plan this amounts to 2.2 – 2.9 Mtonne. So, related to the domestic policy task of 25 Mtonne (see section 3), transport will, in the opinion of VROM (1999), contribute a share of 9 to 11%. In the research evaluation (ECN/RIVM, 1999) of the Policy document, the estimated reduction in emissions is lower than the estimated level in the Policy document (see Table 4). Researchers have estimated that the basic policy set will probably result in a total reduction of 1.3 to 2 Mtonne GHG emission in 2010 compared to BAU. Researchers divided their document into two levels: a robust level (judged feasible) and a potential level (judged potentially feasible, for example, from a technical point of view, but ignored the fact that in normal circumstances not all users will probably adapt to the fuel-efficient technology). So, compared to the forecasted 2010 emissions for transport (see Table 1) the transport options in the Policy document will reduce GHG emissions by 3 - 5% in 2010.

The question of why these eight policy instruments (Table 4) have finally been chosen in the Policy document is difficult to answer because the selection process was not made public. However, especially for transport, it is probable that criteria like short-term feasibility and potential public support have played an important role in the selection. Table 4 shows that the transport options as inventoried in the Option Document (Table 3) can be regarded as an important source of inspiration.

From Table 4 it can be concluded that the differences per policy instrument between the reduction estimates of the Policy document and the potentials, as estimated in the research evaluation are rather small. The main reason for the differences is instrumentation. For research, less clear instrumentation was enough reason to assume no or low emission reduction effects while policymakers were, in general, much more optimistic about the effects of unclear policy. The most important difference is related to the *total* impact of the Policy plan: according to the Policy document the total reduction effect of all transport measures could be estimated as being 2.2 – 2.9 Mtonne, while in the research evaluation an effect of 1.3 – 2 Mtonne was estimated (Table 4). Despite warnings from research, policymakers chose simply to add up all the separate effects of the policy instruments to get a total reduction effect compared to BAU. Conversely, research assumed overlap between the chosen policy instruments. Two kinds of overlap were distinguished. Firstly, instruments which affect technology of the same transport category are not independent of each other. In the Policy document most instruments are related to achieving a more fuel-efficient car fleet and use (Table 4). Therefore it is not correct to add up the separate reduction effects of these instruments, but the final total reduction has to be calculated by multiplying the remaining fractions of the emission factors (g/km CO_2)[3] Secondly, most of the selected instruments attempt to influence the behaviour of the same group of consumers (car owners and users). A set of policy instruments (all kinds of instruments taken together) is expected have a lower impact on behaviour than the impact resulting from ‘adding up’ the behavioural reactions to the separate instruments. In the Research Evaluation report (ECN/RIVM, 1999) this policy instrument overlap is estimated at 0.2 Mtonne in the ‘robust’ estimate and at 0.5 Mtonne in the ‘potential estimate. It should be stressed that these figures are based on expert judgements.

[3] For example, both measures A and B are estimated to result in a CO_2 emission reduction per car kilometre of 20%. The total reduction brought on by the set of measures, A and B collectively, is not 40%, but 36% (i.e. 1-[1-0.2]*[1-0.2]*100%).

Table 4 Estimated GHG emission reduction in the Policy document and the Research Evaluation report

Instrument	Plans for instruments	Reduction effect compared to BAU 2010 (Mtonne CO_2)	Reduction effect compared to BAU 2010 (Mtonne CO_2) **ROBUST**	Reduction effect compared to BAU 2010 (Mtonne CO_2) **POTENTIAL**
		according to Policy document	***according to Research Evaluation***	
EU covenant for more fuel-efficient cars	Covenant with European car manufacturers	0 - 0.4	0	0.4
Feebate system on car purchase tax	Differentiation of 22 Euro per g/km CO_2	0.6	0.6	0.6
Extra enforcement current speed limits	Five to 10 million Euro per year for extra police	0.3	0.1	0.3
Road pricing	Still in debate	0.2	0.2*	0.2*
Fiscal measures to discourage car use in commuting	Plans presented, not totally clear	0.1 - 0.3	0.1	0.3
Increasing tire pressure	Covenant with the industrial branch and continuing publicity	0.3	0.1	0.3
Promoting the use of econometers, cruise control, board computers in cars	Covenant with industrial branch and continuing publicity	0.5	0.5	0.5
Projects aimed at more fuel efficiency	Unclear	0.2 - 0.3	0	0
TOTAL		2.2 - 2.9	1.3	2

* At the time of writing, a limited system of road pricing was still not concrete. So, in view of the ongoing political debate, this assumption has to be regarded as being uncertain.

The methodology to estimate reduction potentials (see Table 4) comprised model calculations, expert judgement and estimates based on the literature. As far as possible, researchers chose to use state-of-the-art scientific methods. It would take too long to describe the methodologies used in detail. However, some important approaches and assumptions will be elucidated below.

4.1 EU covenant

At the end of 1998 the EU and ACEA (European car manufacturers) concluded a covenant. In the covenant it was agreed that from the year 2008 new cars for the EU market would, on average, have a CO_2 emission of 140 g/km (in a test cycle according to EU rules). For the current new cars in the Netherlands this average amounts to approximately 190 g/km (in

'real' circumstances). The estimated GHG emission reduction impact of this covenant was found to be about 0 – 0.4 Mtonne in 2010 compared to BAU. This impact estimate may seem rather pessimistic, but the relatively low reduction effect is mainly due to the assumption that cars in the BAU scenario will autonomously become more fuel-efficient (Feimann *et al.*, 2000). Furthermore: the 140 g/km applies to test circumstances; in reality researchers have assumed a higher CO_2 emission of 150 g/km for new cars in 2008. Finally, it is important to note that the impact of selling more fuel-efficient new cars from the year 2008 will be relatively modest in the year 2010: in 2010 the fleet is not, on average, fully penetrated with these '150 g/km' cars. According to research the average CO_2 emission per kilometre is assumed to drop linearly from 190 to 150 g/km in the 2000-2008 period[4]. Still, it is clear that even if the covenant becomes a total success, the full impact will be in the longer term. For a further discussion on the possible impact of the ACEA Covenant, see Kågeson (2000).
The uncertainty range in the estimated reduction results from the lack of clarity about the manufacturers meeting this agreement: the covenant is an agreement without sanctions, not a law.

4.2 Extra enforcement of current speed limits

The estimation of the impact of the measures on speed limits was based on a detailed study of Peeters *et al.* (1996). Three effects were included: a) a direct effect, since speed reduction will result directly in a lower CO_2 emission per kilometre, b) the rebound effect: increase on car use due to a decrease in fuel costs and c) an indirect effect, since speed reduction will result in longer travel times and therefore fewer car kilometres. A travel time elasticity (of car use) of –1.27 was used (Peeters *et al.*, 1996, based on Van der Waard, 1990). After finishing the research evaluation, reviewers assessed this travel time elasticity as probably being too high. So the emission reduction estimates for the measures on car speed limits have to be considered as upper-bound. For example, Goodwin (1996) calculated a long-term travel time elasticity of –1. A travel time elasticity of 0 was assumed for lorries This assumption could be regarded as probably lower-bound. The uncertainty range of the research in estimated reduction is due to not being clear about the extent to which sending in extra police agents will result in better enforcement of the current speed limits and to the uncertainties in the travel time elasticities.

4.3 Feebate

A feebate is a system where car buyers get a rebate when they buy a car that is more fuel-efficient than the average fuel-efficient car in a certain car class. Additionally, they have to pay a fee when they buy a car which is less fuel-efficient than the average car in that particular car class. The effect of the proposed Dutch feebate measure was based on an American model study by Davis *et al.* (1995). The American results were scaled down to suit Europe, where the fleet is already more fuel-efficient. Another reason was the non-existent expectation that car manufacturers will react by supplying much more fuel-efficient cars on the Dutch market if a measure like this is taken only in the Netherlands, with its relatively

[4] It is possible that the average CO2 emission per kilometre will not drop linearly between 2000 and 2008 but that the decrease is lower than average in the beginning op this period and higher than average at the end of the period. If so the effect of the ACEA Convenant will be slightly over-estimated.

small car market. Supply reactions in the American study constitute an important explanation of the effects occurring.

4.4 Promoting the use of econometers, cruise control and board computers

The estimation of effects when promoting the use of econometers, cruise control and board computers was based on demonstration projects (Wilbers, 1994; NOVEM, 1998).

4.5 Rebound effect

In general, researchers have taken a rebound effect into consideration for all policies (see Table 4) resulting in a higher car-fuel efficiency. The rebound effect is defined as: the increase in car kilometres due to the lower fuel costs (as a result of improved fuel efficiency). Rebound effects due to lower fixed costs were not considered. A non-symmetrical rebound effect of –0.2 (fuel cost elasticity of car use) based on Dargay and Gately (1997) was assumed.

5. Discussion

In this section we will discuss the Kyoto-related transport policies and research as described so far. This section has partly been inspired by Van Wee and Annema (1999), who reviewed three European engineering-economic transport studies.

With regard to the Kyoto-related transport policies in the Netherlands, we have taken note of two important weak points. The first weak point is the limited selection of instruments in the first research stage, focusing mainly on car-related measures and instruments. The instruments evaluated in the first phase of the research were selected by policymakers. Instruments which because of equity or lack of support by society or policy were considered to be difficult to implement were pre-excluded. This exclusion was based on a gut feeling rather than careful analysis. Such an approach, which, for example excludes all kinds of options in goods transport, may easily lead to possibly attractive options being ignored. To us, it would seem advisable to survey a relatively large list of GHG emission reduction options in the first research stage, both for other road categories than cars and for non-road categories. Close cooperation between policymakers and researchers should result in the optimal list. This should not be too short, as we think has been the case in the Dutch Kyoto policy-making process, or too long, as will probably be the case if the choice of options is left to the decision of researchers only. The second weak point in the contents of the Kyoto-related transport policies in the Netherlands is the limited time horizon of ten years. The focus on 2010 can be easily explained by the time horizon of the Kyoto Protocol. However, this focus implies that longer-term instruments and measures have not been considered but may be very relevant. This is especially important because the greenhouse effect may be found more important in the much longer term, making other ‘long-term instruments and measures’ relevant. These longer term instruments and measures may require policy actions in the short term. These actions were this time not considered in the Kyoto-related policy process (see also AER, 1998; VROM-raad, 1998).

On the research methodology used in the Kyoto-related transport policies in the Netherlands we notice one very important weak point: the poor definition of costs and cost-effectiveness. In the Option Document national and end-user costs, and costs of the policy options to the government, were poorly determined. After much discussion between the different researchers, it was decided to limit costs to 'out-of-pocket' money. This is a very limited approach since it has resulted in incomplete 'cost' estimations. For example, the cost-effectiveness of the levy increases (see Table 3) was presented as being negative: the levy increase results in savings since less fuel has to be bought compared to BAU; at the same time, the levy increase reduces CO_2 emission in comparison to the BAU level. However, costs like 'loss of mobility' (compared to BAU, fewer car kilometres are driven), and 'loss of comfort' (people are perhaps stimulated to buy smaller and lighter – less comfortable – cars, compared to BAU) are not included. This limited use of the cost notion could, from a societal point of view, have easily resulted in non-optimal policy instruments. With respect to costs our impression is that total costs hardly counted in the final round of the Kyoto-related policy process for transport. The option of levy increase illustrates our impression: i.e. the lower costs resulting from a levy increase, as suggested by the research, did not lead to selection of this option in the Policy document.

Related to the discussion about the poor use of the cost aspects, it is, in our opinion, advisable for researchers evaluating the impact of policy options to present as much relevant information as possible. The information could include (1) impact on economic indicators: the costs (and then not only in terms of 'out-of-pocket' money), as well as other economic impacts, such as the impact on employment, GDP, consumer and producer surpluses, and impacts on accessibility (as far as this has an economic impact); (2) impact on environmental indicators: the effects on other emissions, other environmental aspects, e.g. noise, concentrations of pollutants, negative impacts on nature and landscapes, and less traditional environmental indicators such as nuisance of parked and driving vehicles, and (3) impacts on other societal indicators, such as safety impacts, equity impact, accessibility as far as the non-economic aspects are concerned and public support. By presenting this information for all options, policymakers obtain insight into impacts of policy options from a broad perspective, which could improve the quality of the selection process when choosing between options.

For the Netherlands as a whole (not only transport), the Research Evaluation report (ECN/RIVM, 1999) concluded that the Policy document will result in a robust emission reduction of 15 Mtonne GHG emissions, and in a potential reduction of 26 Mtonne in 2010 compared to BAU. The largest share in reduction is expected to come from the energy production companies, industry and households, which together contribute 60%. The expected share of transport in reduction is rather modest: due to Dutch Kyoto policy, transport will contribute with a share of 5 to 8%, which is lower than the transport share in total Dutch GHG emissions of approximately 15%.

From the gap between the goal and the robust emission reduction estimate of 15 Mtonne for all sources, we can see, when making use of a metaphor from the world of transport to end this section, that Dutch policymakers will have to 'set out all their sails' if they are to meet the policy task of realising a 25 Mtonne reduction in emissions.

6. Conclusions and evaluation

Research has played a major role in both the development and the evaluation of Dutch Kyoto-related policy. Researchers have estimated that related to the domestic policy task of 25 Mtonne GHG emission reduction in 2010, transport will contribute 5-8%; this is lower than their share in the total Dutch GHG emissions due to Dutch Kyoto policy. The most effective instruments are tax differentiation for new cars and in-car instruments such as economy meters and cruise control.

The 2008-2012 Kyoto target period meant that this period would be focused on. However, many possible relevant measures for transport may not or may hardly have effects by then. Such measures were not included in the process but may be relevant in meeting possible future (international) targets for GHG emissions. Nearly all instruments that were discussed in the Kyoto-related research and policy-making process are

correlated. The reason for this focus is an *a priori* choice of policymakers. However, cost-effective options for other vehicle categories (road transport and non-road transport) may be available.

The Dutch Kyoto-related policy-making process was highly merited on the close interaction between research and policymakers. Also, the chosen evaluation criteria and the method used in the process appeared logical and was fairly easy to put into practice. However, looking at the Dutch Kyoto-related policy-making process, there are also some lessons to learn. Firstly, researchers and policymakers in these processes should be aware of the importance of drawing up a relatively large list of options in the early stages of the policy-making process, including those which may have their full impacts in the long term. Secondly, researchers should try to avoid confusion about the impact of options, which are sometimes defined as measures and sometimes as policy instruments. The lesson is that in these kinds of policy-making processes, one cannot be clear enough about the assumptions used to assess the impact of options. The third lesson is that researchers should improve their methods for estimating costs and cost-effectiveness of measures and instruments, especially the inclusion of indirect costs should receive attention. Finally, the evaluation showed that in evaluating the impact of policy options it advisable for researchers to present as much relevant information as possible, including (1) impact on environmental indicators, (2) impact on economic indicators (more than only costs) and (3) impacts on other social indicators.

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